Constant Low-Field Mobility Model

In ATLAS, the choice of mobility model is specified on the MODELS statement. The parameters associated with mobility models are specified on a separate MOBILITY statement. One or more mobility models should always be specified explicitly. The default is to use constant low-field mobilities within each region of a device. This default model is independent of doping concentration, carrier densities and electric field. It does account for lattice scattering due to temperature according to:

$$\mu_{n0} = \mathrm{MUN}\left(\frac{T_L}{300}\right)^{-\mathrm{TMUN}} \quad \text{3-180}$$

$$\mu_{p0} = \mathrm{MUP}\left(\frac{T_L}{300}\right)^{-\mathrm{TMUP}} \quad \text{3-181}$$

where T is the lattice temperature. The low-field mobility parameters: MUN, MUP, TMUN, and TMUP can be specified in the MOBILITY statement with the defaults as shown in Table 3-29.

Table 3-29 User-Specifiable Parameters for the Constant Low-Field Mobility Model

Statement	Parameter	Default	Units
MOBILITY	MUN	1000	$cm^2/(V{\cdot}s)$
MOBILITY	MUP	500	$cm^2/(V{\cdot}s)$
MOBILITY	TMUN	1.5	
MOBILITY	TMUP	1.5	

Concentration-Dependent Low-Field Mobility Tables

ATLAS provides empirical data for the doping dependent low-field mobilities of electrons and holes in silicon at T_L=300K only. This data is used if the CONMOB parameter is specified in the MODELS statement. The data that is used is shown in Table 3-30.

Table 3-30 Mobility of Electrons and Holes in Silicon at T=300K

Concentration (cm^{-3})	Mobility ($cm^2/V{\cdot}s$)	
	Electrons	Holes
1.0×10^{14}	1350.0	495.0
2.0×10^{14}	1345.0	495.0
4.0×10^{14}	1335.0	495.0
6.0×10^{14}	1320.0	495.0
8.0×10^{14}	1310.0	495.0

Table 3-30 Mobility of Electrons and Holes in Silicon at T=300K		
Concentration (cm^{-3})	Mobility ($cm^2/V \cdot s$)	
	Electrons	Holes
1.0×10^{15}	1300.0	491.1
2.0×10^{15}	1248.0	487.3
4.0×10^{15}	1200.0	480.1
6.0×10^{15}	1156.0	473.3
8.0×10^{15}	1115.0	466.9
1.0×10^{16}	1076.0	460.9
2.0×10^{16}	960.0	434.8
4.0×10^{16}	845.0	396.5
6.0×10^{16}	760.0	369.2
8.0×10^{16}	720.0	348.3
1.0×10^{17}	675.0	331.5
2.0×10^{17}	524.0	279.0
4.0×10^{17}	385.0	229.8
6.0×10^{17}	321.0	2103.8
8.0×10^{17}	279.0	186.9
1.0×10^{18}	252.0	178.0
2.0×10^{18}	182.5	130.0
4.0×10^{18}	140.6	90.0
6.0×10^{18}	113.6	74.5
8.0×10^{18}	99.5	66.6
1.0×10^{19}	90.5	61.0
2.0×10^{19}	86.9	55.0
4.0×10^{19}	83.4	53.7
6.0×10^{19}	78.8	52.9
8.0×10^{19}	71.6	52.4
1.0×10^{20}	67.8	52.0
2.0×10^{20}	52.0	50.8

Table 3-30 Mobility of Electrons and Holes in Silicon at T=300K		
Concentration (cm^{-3})	Mobility ($cm^2/V \cdot s$)	
	Electrons	Holes
4.0×10^{20}	35.5	49.6
6.0×10^{20}	23.6	48.9
8.0×10^{20}	19.0	48.4
1.0×10^{21}	17.8	48.0

Analytic Low-Field Mobility Model

The following analytic function based upon the work of Caughey and Thomas [41, 246] can be used to specify doping- and temperature-dependent low-field mobilities.

$$\mu_{n0} = \mathrm{MU1N.CAUG} \cdot \left(\frac{T_L}{300K}\right)^{\mathrm{ALPHAN.CAUG}} + \frac{\mathrm{MU2N.CAUG} \cdot \left(\frac{T_L}{300K}\right)^{\mathrm{BETAN \cdot CAUG}} - \mathrm{MU1N.CAUG} \cdot \left(\frac{T_L}{300K}\right)^{\mathrm{ALPHAN \cdot CAUG}}}{1 + \left(\frac{T_L}{300K}\right)^{\mathrm{GAMMAN.CAUG}} \cdot \left(\frac{N}{\mathrm{NCRITN.CAUG}}\right)^{\mathrm{DELTAN.CAUG}}} \quad \text{3-182}$$

$$\mu_{p0} = \mathrm{MU1P.CAUG} \cdot \left(\frac{T_L}{300K}\right)^{\mathrm{ALPHAP \cdot CAUG}} + \frac{\mathrm{MU2P.CAUG} \cdot \left(\frac{T_L}{300K}\right)^{\mathrm{BETAP \cdot CAUG}} - \mathrm{MU1P.CAUG} \cdot \left(\frac{T_L}{300K}\right)^{\mathrm{ALPHAP \cdot CAUG}}}{1 + \left(\frac{T_L}{300K}\right)^{\mathrm{GAMMAP \cdot CAUG}} \cdot \left(\frac{N}{\mathrm{NCRITP.CAUG}}\right)^{\mathrm{DELTAP \cdot CAUG}}} \quad \text{3-183}$$

where N is the local (total) impurity concentration in cm^{-3} and T_L is the temperature in degrees Kelvin.

This model is activated by specifying ANALYTIC in the MODELS statement. The parameters of this model are specified in the MOBILITY statement. The default parameters are for silicon at T_L = 300K.